



US009205627B2

(12) **United States Patent**  
**Torriani et al.**

(10) **Patent No.:** **US 9,205,627 B2**  
(45) **Date of Patent:** **Dec. 8, 2015**

(54) **METHOD FOR PRODUCING A  
LIGHTWEIGHT COMPONENT, AND  
SUPPORT ELEMENT**

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(\*) Notice: Subject to any disclaimer, the term of this  
patent is extended or adjusted under 35  
U.S.C. 154(b) by 202 days.

(21) Appl. No.: **14/066,136**

(22) Filed: **Oct. 29, 2013**

(65) **Prior Publication Data**

US 2014/0057067 A1 Feb. 27, 2014

**Related U.S. Application Data**

(63) Continuation of application No. 13/126,005, filed as  
application No. PCT/CH2009/000343 on Oct. 27,  
2009, now Pat. No. 8,597,446.

(30) **Foreign Application Priority Data**

Oct. 28, 2008 (CH) ..... 1690/08

(51) **Int. Cl.**

**B29C 65/48** (2006.01)

**B29C 65/52** (2006.01)

(Continued)

(52) **U.S. Cl.**

CPC . **B32B 3/06** (2013.01); **B27D 5/003** (2013.01);  
**B29C 63/0026** (2013.01);

(Continued)

(58) **Field of Classification Search**

CPC .... B29C 63/0026; B29C 65/00; B29C 65/02;  
B29C 65/08; B29C 65/085; B29C 65/18;  
B29C 65/645; B29C 66/20; B29C 66/221;  
B29C 66/223; B29C 66/3022; B29C 66/303;  
B29C 66/3452; B29C 66/43; B29C 66/47;

B29C 66/534; B29C 66/5346; B29C 66/71;  
B29C 66/7212; B29C 66/72525; B29C  
66/73161; B29C 66/7392; B29C 66/7486;  
B29C 66/7487; B32B 3/06; B32B 38/0036;  
B32B 2309/02; B27D 5/003; Y10T 428/239;  
Y10T 428/24008; B29K 2023/04; B29K  
2023/06; B29K 2023/10; B29K 2023/12;  
B29K 2025/00; B29K 2027/06; B29K  
2055/02; B29K 2067/00; B29K 2069/00;  
B29K 2077/00; B29K 2101/12; B29K  
2105/12; B29K 2351/04; B29K 2309/08;  
B29K 2311/12; B29K 2311/14

USPC ..... 156/73.1, 73.5, 308.2, 308.4, 309.6;  
428/99; 264/442–445

See application file for complete search history.

(56) **References Cited**

**U.S. PATENT DOCUMENTS**

3,595,237 A \* 7/1971 Sargent et al. .... 604/370  
4,244,069 A \* 1/1981 Hale ..... 412/33

(Continued)

**FOREIGN PATENT DOCUMENTS**

DE 202006010157 11/2007  
EP 1640128 3/2006

(Continued)

*Primary Examiner* — Sing P Chan

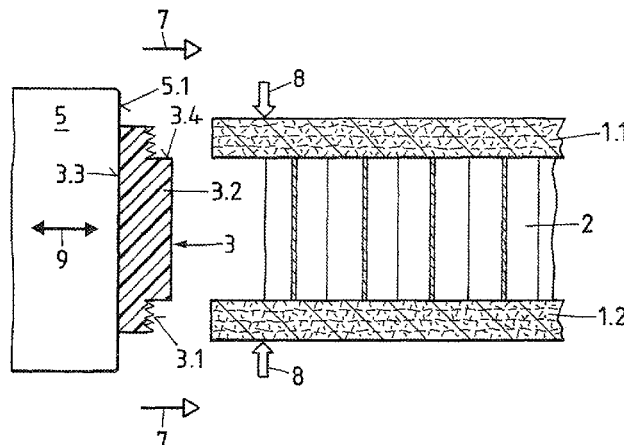
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**ABSTRACT**

A lightweight component is equipped with two cover layers, which are made of a wood material, and a filling disposed in between the layers after cutting everything to size, having an edge support including thermoplastic material. The edge support is anchored in both the first and second cover layers starting from the narrow side. Anchoring is achieved by bringing the edge support into contact with the respective cover layer and coupling mechanical vibrations into the edge support by a sonotrode engaging from the narrow side. The edge support at the same time is pressed against the cover layer such that, in the region of a transition between the thermoplastic material and the wood material of the cover layer, part of the thermoplastic material is liquefied and pushed into the cover layer material, thereby producing a positively engaged anchoring after hardening.

**17 Claims, 5 Drawing Sheets**



## (51) Int. Cl.

*B32B 37/04* (2006.01)  
*B32B 37/12* (2006.01)  
*B32B 43/00* (2006.01)  
*C08J 5/12* (2006.01)  
*B32B 3/06* (2006.01)  
*B29C 63/00* (2006.01)  
*B29C 65/08* (2006.01)  
*B29C 65/64* (2006.01)  
*B29C 65/00* (2006.01)  
*B27D 5/00* (2006.01)  
*B29K 23/00* (2006.01)  
*B29K 27/06* (2006.01)  
*B29K 55/02* (2006.01)  
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*B29K 77/00* (2006.01)  
*B29K 101/12* (2006.01)  
*B29K 105/12* (2006.01)  
*B29K 311/12* (2006.01)  
*B29K 311/14* (2006.01)  
*B29K 707/04* (2006.01)  
*B29K 709/08* (2006.01)  
*B29L 31/44* (2006.01)  
*B29L 31/60* (2006.01)

## (52) U.S. Cl.

CPC ..... *B29C 65/08* (2013.01); *B29C 65/645*  
 (2013.01); *B29C 66/20* (2013.01); *B29C*  
*66/534* (2013.01); *B29C 66/5346* (2013.01);  
*B29C 66/72525* (2013.01); *B29C 66/7392*  
 (2013.01); *B29C 66/73161* (2013.01); *B29C*  
*66/7486* (2013.01); *B29C 66/7487* (2013.01);  
*B29C 66/80* (2013.01); *B29C 65/085* (2013.01);  
*B29C 66/221* (2013.01); *B29C 66/223*  
 (2013.01); *B29C 66/303* (2013.01); *B29C*  
*66/3022* (2013.01); *B29C 66/3452* (2013.01);  
*B29C 66/47* (2013.01); *B29C 66/71* (2013.01);  
*B29C 66/7212* (2013.01); *B29K 2023/06*  
 (2013.01); *B29K 2023/12* (2013.01); *B29K*  
*2027/06* (2013.01); *B29K 2055/02* (2013.01);  
*B29K 2069/00* (2013.01); *B29K 2077/00*  
 (2013.01); *B29K 2101/12* (2013.01); *B29K*  
*2105/12* (2013.01); *B29K 2311/12* (2013.01);  
*B29K 2311/14* (2013.01); *B29K 2707/04*  
 (2013.01); *B29K 2709/08* (2013.01); *B29L*  
*2031/44* (2013.01); *B29L 2031/608* (2013.01);  
*Y10T 428/239* (2015.01); *Y10T 428/24008*  
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## (56)

## References Cited

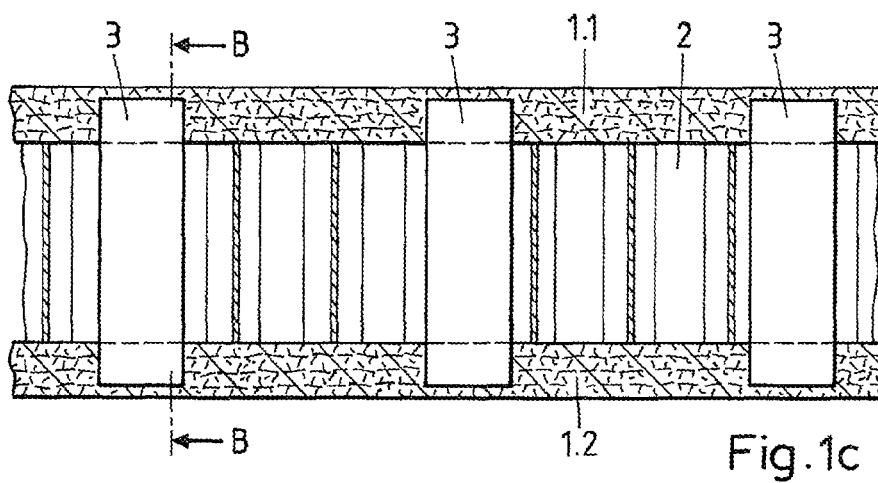
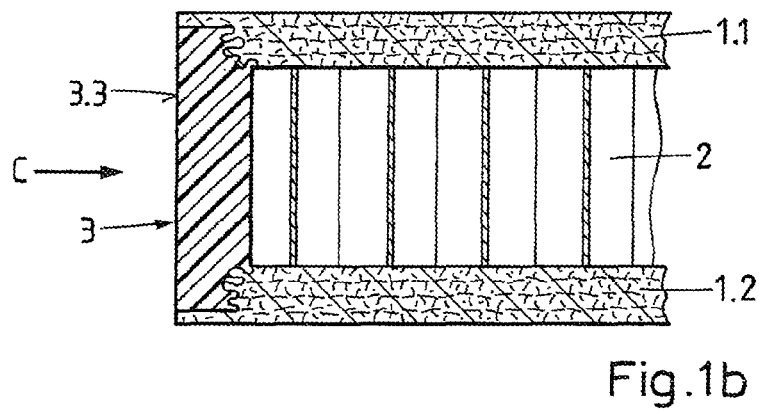
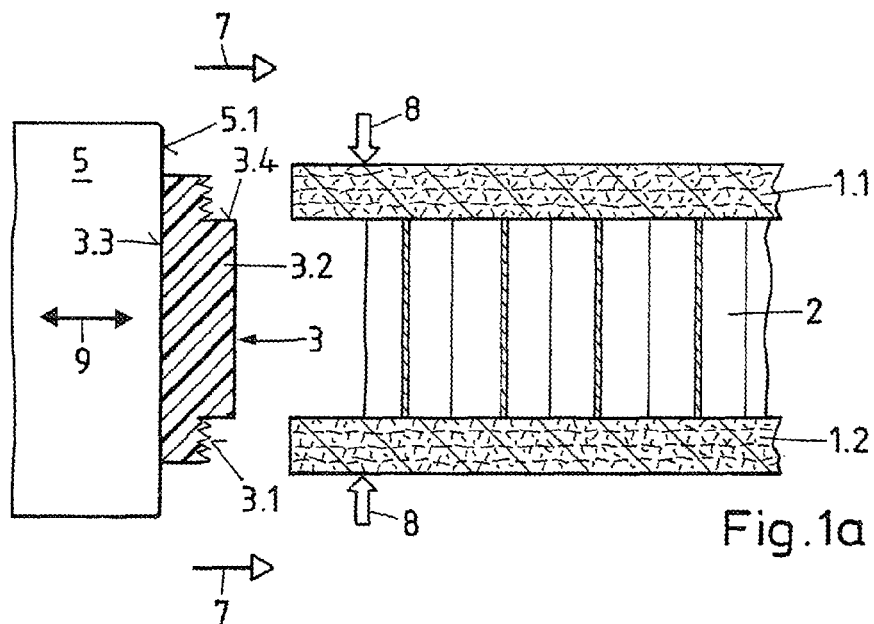
## U.S. PATENT DOCUMENTS

4,374,187	A *	2/1983	Sano	429/175
4,459,793	A *	7/1984	Zenger	53/434
4,466,553	A *	8/1984	Zenger	220/495.08
4,663,912	A *	5/1987	Vinther	52/797.1
4,722,146	A *	2/1988	Kemeny	40/605
4,748,970	A *	6/1988	Nakajima	600/158
4,761,319	A *	8/1988	Kraus et al.	428/99
4,765,105	A *	8/1988	Tissington et al.	52/309.11
4,782,968	A *	11/1988	Hayes	215/276
4,948,006	A *	8/1990	Okabe et al.	220/611
5,580,097	A *	12/1996	Latvakangas et al.	281/29
5,743,204	A *	4/1998	Tweet	114/219
5,853,577	A *	12/1998	Gizowski et al.	210/167.08
5,950,389	A *	9/1999	Porter	52/586.1
5,965,238	A *	10/1999	Saitoh et al.	428/178
6,029,416	A *	2/2000	Andersson	52/592.1
6,131,521	A *	10/2000	Nelson et al.	108/27
6,183,585	B1 *	2/2001	Kelley	156/182
6,233,896	B1 *	5/2001	Coup	52/586.1
6,479,006	B1 *	11/2002	Kaufmann	264/275
6,490,828	B1 *	12/2002	Fuller et al.	52/36.1
6,502,341	B1	1/2003	Truc	
6,607,798	B1	8/2003	Watanabe	
6,786,007	B2 *	9/2004	Aritake	49/506
6,982,021	B2 *	1/2006	Spengler	156/221
7,658,810	B2 *	2/2010	Endres et al.	156/210
7,892,631	B2 *	2/2011	Bauer	428/218
8,176,704	B2 *	5/2012	Gauss et al.	52/717.05
8,230,659	B2 *	7/2012	Langille et al.	52/741.3
8,426,006	B2 *	4/2013	de Groot	428/76
8,945,327	B2 *	2/2015	Stamp et al.	156/213
2003/0041955	A1 *	3/2003	Spengler	156/221
2003/0163972	A1 *	9/2003	Angenendt et al.	52/793.1
2003/0188491	A1 *	10/2003	Aritake	49/490.1
2006/0046139	A1 *	3/2006	Suzuki et al.	429/175
2006/0210777	A1 *	9/2006	Bauer	428/192
2007/0125601	A1 *	6/2007	Lutze	182/222
2008/0201938	A1 *	8/2008	Gauss et al.	29/700
2010/0129584	A1 *	5/2010	de Groot	428/53
2011/0314755	A1 *	12/2011	Langille et al.	52/232
2012/0315429	A1 *	12/2012	Stamp et al.	428/72
2013/0236688	A1 *	9/2013	Stamp et al.	428/116

## FOREIGN PATENT DOCUMENTS

EP	1698738	9/2006
EP	1731236	12/2006
EP	1932637	6/2008
EP	1961533	8/2008

\* cited by examiner



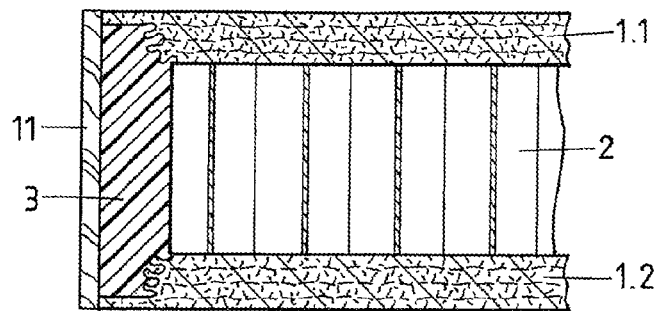


Fig. 1d

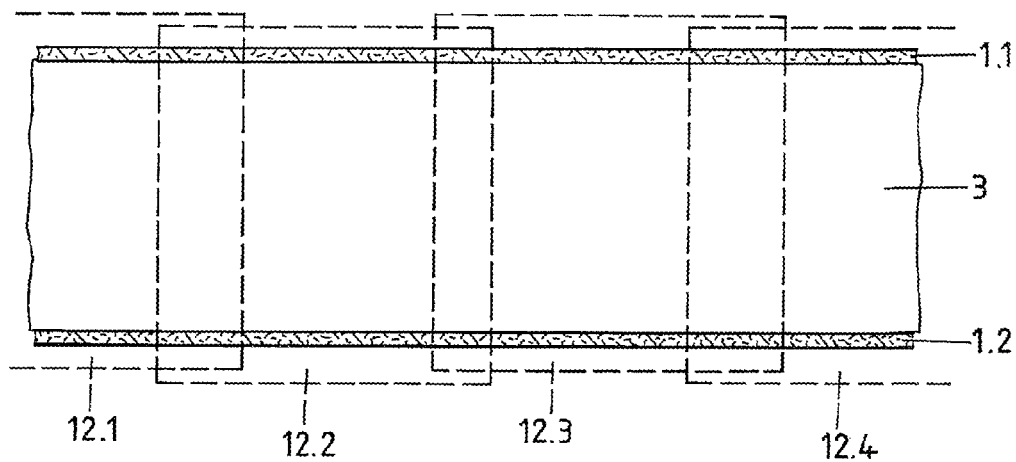


Fig. 2

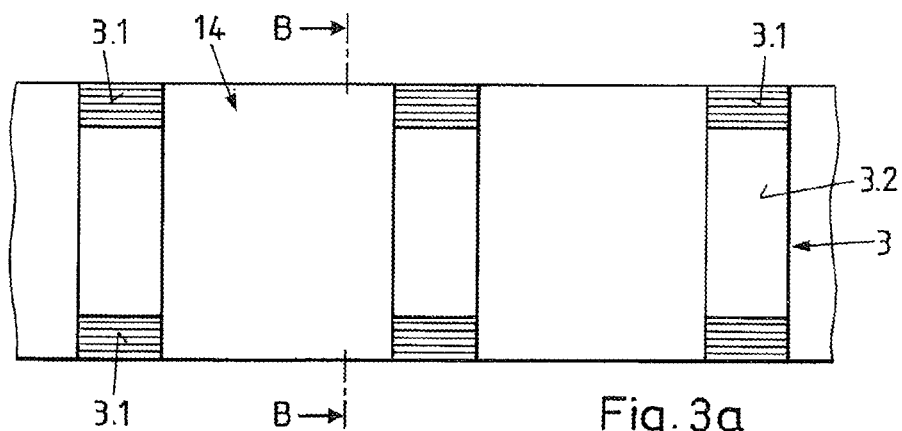


Fig. 3a

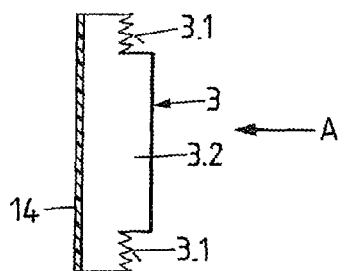


Fig. 3b

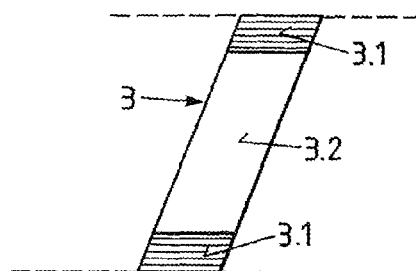


Fig. 4

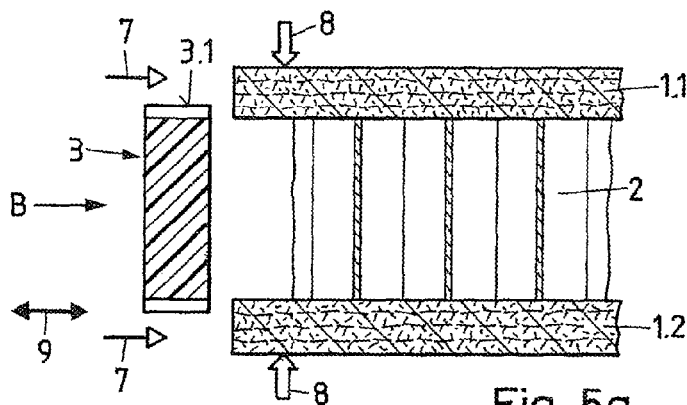


Fig. 5a

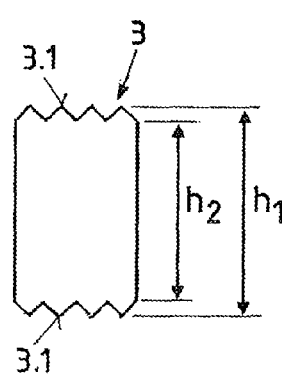


Fig. 5b

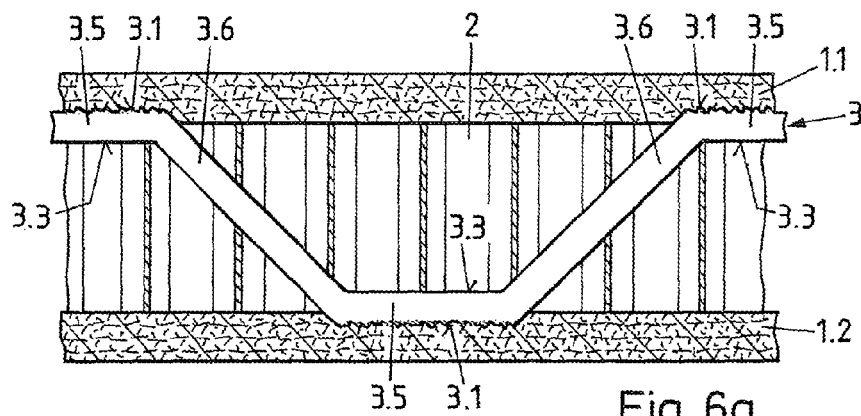
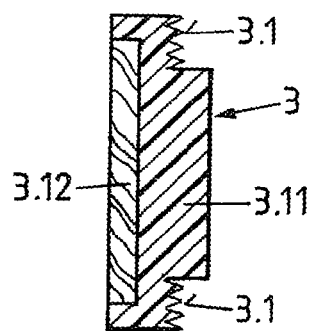
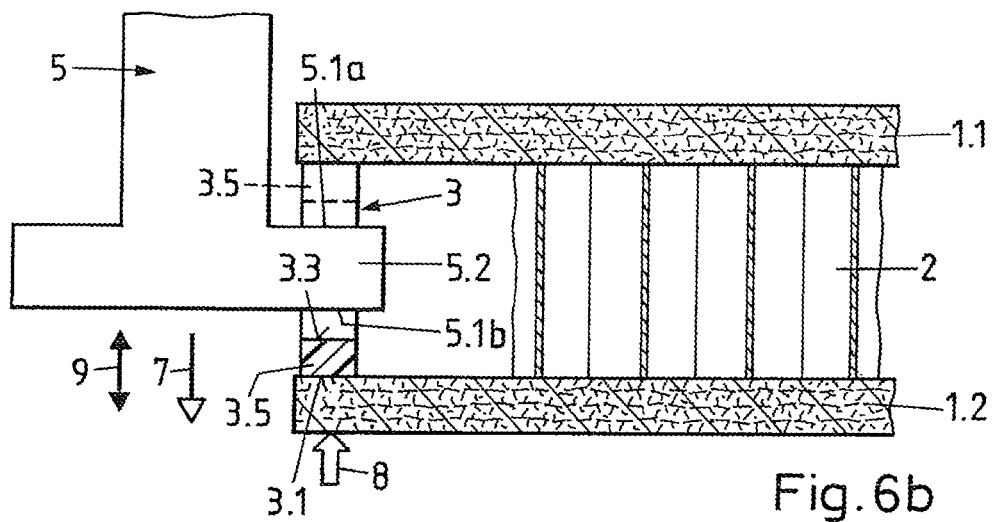


Fig. 6a



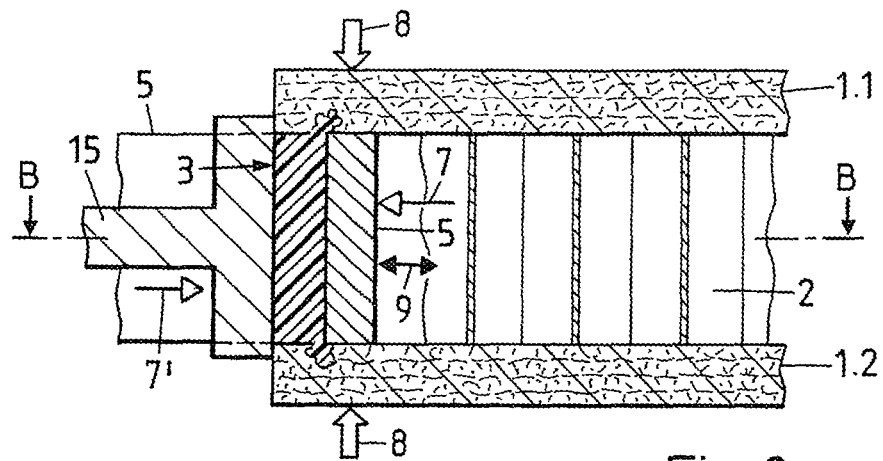


Fig. 8a

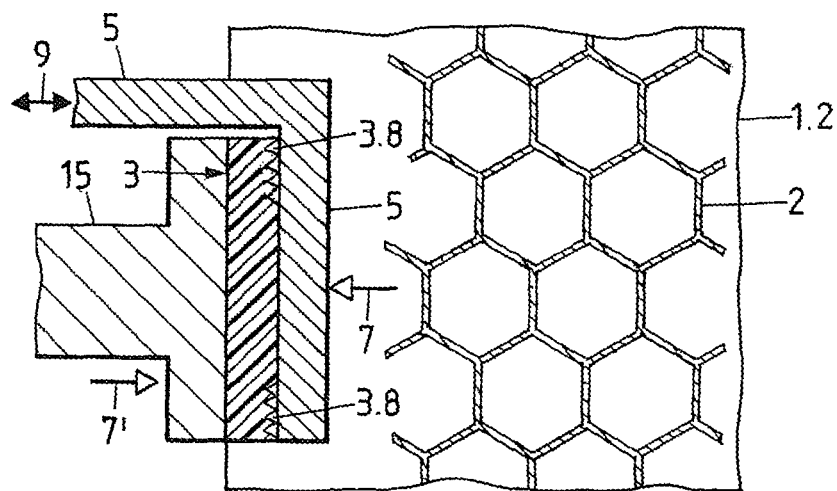


Fig. 8b

# METHOD FOR PRODUCING A LIGHTWEIGHT COMPONENT, AND SUPPORT ELEMENT

## BACKGROUND OF THE INVENTION

### Field of the Invention

The invention relates to lightweight building boards, as used in lightweight construction and the furniture industry.

Such lightweight building boards consist of two outer, relatively thin cover layers, for example particleboards, and a filling, for example a honeycomb structure made of card, arranged between the cover layers. Lightweight building boards of this type are mechanically very stable, lightweight, and can look attractive if the edges are finished neatly. Specifically because of their low weight and also because of the low consumption of resources in their production, they are becoming increasingly popular.

Edges (decorative edges) for such lightweight building boards are, for example, plastic strips sealed on the outer surface and provided with a suitable decoration, and may furthermore be provided with an adhesive on the rear side. Decorative edges formed as veneer edges are also available.

However, finishing the edges in such a way as to obtain an attractive appearance has, to some extent, not yet been satisfactorily accomplished. In particular, for the production of ready-made and mass-produced products, it would be desirable if a cut-to-size lightweight building board could be provided with an edge by a craftsman after the cutting-to-size operation, without involving great effort and using available tools.

For the secure fastening of the edge, the prior art discloses on the one hand the provision of a so-called crosspiece, that is a particle profile completely filling the intermediate space between the cover layers in the region of the edge. A commercially available edge of the desired type can then be adhesively attached to such a crosspiece. Such crosspieces are mechanically very stable. However, they contribute significantly to the overall weight of the board and can only be retrofitted with considerable effort. They are therefore suitable in particular for fitting at the time that the lightweight building board is made, and consequently particularly for industrial production.

On the other hand, so-called support edges are known. These are plastic strips or plastic laths which are attached to the edge between the cover layers, the cover layers generally also being milled on the inside. The actual edge with the decoration is then glued onto this support edge. The document EP 1 640 128 shows as a variant a method in which the edge is glued onto the support edge before the support edge is attached.

The support edge technique is also quite laborious and necessitates the use of machines especially provided for the support edges. For anything other than industrial production, their use entails disadvantages and is even virtually impossible.

## BRIEF SUMMARY OF THE INVENTION

It is consequently an object of the invention to provide a method for producing a lightweight component and a support element intended for such a method that overcome disadvantages of the prior art and, in particular, are also suitable for non-industrial production.

According to one aspect of the invention, it is proposed to provide the lightweight component having two cover layers,

for example of wood or a derived timber material, and a filling arranged in between with an edge support comprising a thermoplastic material (generally a plastic containing a thermoplastic polymer) after the cutting-to-size operation. This takes place in such a way that said edge support is anchored from the narrow side both in the first cover layer and in the second cover layer, wherein the anchorage is achieved by the edge support being brought into contact with the respective cover layer and mechanical vibrations being coupled into the edge support by a sonotrode approaching from the narrow side (that is to say, not through the cover layers), wherein the edge support at the same time is pressed against this cover layer in such a way that, in the region of a transition between the thermoplastic material and the derived timber material of the cover layer, part of the thermoplastic material is liquefied and forced into the cover layer material, thereby producing a positively engaging anchorage after hardening. This is carried out with one extended edge support in a continuous process or with a plurality of edge supports in a repeated process until an extended region of the narrow side ('extended' means, for example, that the 'horizontal' extent along the narrow side is much greater than the thickness of the lightweight component) is provided with the edge support or with the edge supports (and under some circumstances with intermediate spaces between them). Furthermore, an edge is fastened to the edge support or to the edge supports in such a way that, in said extended region, the intermediate space between the cover layers is closed toward the narrow side.

According to a further aspect of the invention, a method for fastening an edge to a lightweight component having two cover layers and a filling arranged in between is provided, the method comprising the following method steps:

providing an edge support (3) comprising a thermoplastic material;

anchoring the edge support (3) in both cover layers (1.1, 1.2), the anchorage taking place by the edge support being brought into contact with the respective cover layer and energy being coupled into the edge support, the edge support (3) at the same time being pressed against this cover layer (1.1, 1.2) in such a way that, in the region of a transition between the thermoplastic material and the cover layer, part of the thermoplastic material is liquefied and forced into the cover layer, whereby a positively engaging anchorage is obtained after hardening of the thermoplastic material;

carrying out or repeating the anchorage until an extended region of the narrow side is provided with the edge support (3) or with a plurality of edge supports (3);

fastening an edge (11; 14) to an outer surface of the edge support in such a way that, in said extended region, the intermediate space between the cover layers is closed toward the narrow side.

According to the first aspect, the supplying of energy may take place by a sonotrode, through which vibrations are coupled into the edge support. The vibrations can be coupled into the edge support in such a way that they are transmitted through the latter to an interface with the cover layers and the liquefaction takes place as a result of the friction between the cover layer and the thermoplastic material and/or internal friction of the thermoplastic material (for example assisted by energy directors) in the region of the interface with the cover layers. As a variant, the liquefaction may also be brought about in contact with a counter element, which may, for example, engage behind an edge support in an L-shaped manner and with which the pressure of the sonotrode is opposed. However, the coupling may also take place by the liquefaction taking place directly in contact with the



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sonotrode, i.e. the mechanical vibrations are coupled in with a depth of penetration that under some circumstances is restricted. Also in these embodiments, the liquefied thermoplastic material is pressed outward and into structures of the cover layers by the compressive force. In this case, the sonotrode may, for example, engage behind the edge support in an L-shaped manner, so that the liquefaction takes place on the inside of the edge support with respect to the lightweight component. A counter element acting from the outside is used to exert a force counter to the pressing force of the sonotrode.

With regard to the liquefaction in direct contact with the sonotrode or a counter element, attention is also drawn to the document WO 2009/052 644, to the content of which reference is expressly made here.

The supplying of energy may alternatively also be brought about in some other way, mechanically, by heating or by radiation coupled in for example through the edge support, which is absorbed at the roughened or for some other reason absorbent interface between the edge support and the cover layer.

Terms concerning the spatial orientation such as “horizontal” or “vertical”, “upper side”, “underside”, etc. are used in the present text to make it easier to read. They relate to the lightweight component when it has been placed with a flat side on a planar surface, with the cover layers horizontal. They should not of course be interpreted as meaning that the method described only works in this orientation. It goes without saying that—particularly for relatively small lightweight components—it can also be carried out, for example, with the lightweight component oriented vertically or with the lightweight component held at an angle.

The procedure according to the invention produces the important advantage that it allows the use of a relatively low-cost element—the edge support—which can also be used with simple means—that is, for example, an ultrasonic device with a sonotrode. The ultrasonic device with the sonotrode may be a portable device (“handheld device”) or a device similar to a fixedly installed drilling machine carried by a frame, with which it is possible to carry out not only the fastening of the edge support but also other working steps. The ultrasonic device may also be a customary stationary ultrasonic machine, as also known for industrial applications; the procedure according to the invention is also suitable for industrial application.

The procedure according to the invention also makes it possible that the filling in the region of the narrow side does not have to be cleared out—and is preferably used as such. Even if it comprises regions running between the cover layers in the final state, the edge support requires little depth, and, given sufficiently flexible filling material, said material can be readily forced in.

Furthermore, the invention makes it possible that the cover layers do not have to be pretreated—for example by providing channels, grooves, etc.—i.e. the at least one edge support is preferably fastened after the cutting-to-size operation, without method steps that are specifically designed for the edge support, although such steps are not ruled out.

The fastening of the edge preferably takes place after the anchorage of the edge support(s). Between the anchoring step and the edge-fastening step, it is possible, for example, for projecting parts of the edge, and possibly of the edge support(s), also to be milled off. If the fastening takes place after the anchorage of the edge support(s), it is also possible in particular for curved or angled-away narrow sides to be edged, without excessive stresses occurring.

However, the edge may also be fastened before the anchorage of the edge support; this can already take place during

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production, i.e. the edge may be constructed during production in such a way that it comprises the edge support. This also includes edge/edge-support assemblies produced as one piece, i.e. in this embodiment the edge and the edge support(s) may also be an integrated, homogeneous or heterogeneous component. The coupling-in of the mechanical oscillations then takes place through the edge; the sonotrode therefore acts on the outside of the edge.

During the anchorage of the edge support, a supporting force that is directed inward—that is to say toward the other cover layer respectively—is preferably exerted on the cover layer or the cover layers. This supporting force prevents the cover layers from coming apart when the supporting edges are introduced; this helps, inter alia, to maintain the thickness tolerances of the lightweight building board.

According to the first aspect of the invention, the sonotrode acts from the narrow side, therefore does not act through the cover layers. Nevertheless, the edge support preferably lies substantially between the cover layers after the anchorage, that is to say projects at most a little, and preferably not at all, beyond the cover layers on the rear side (i.e. a large part of the volume, for example at least  $\frac{2}{3}$  or at least 80% of the volume, of the edge support material is preferably located between the cover layers after anchorage). It is particularly preferred for the support edge to be flush on the outside, or even set deeper, so that, during finishing (for example milling to obtain the necessary planarity) before the actual edge is applied, only perhaps cover layers or a little of the edge support is/are milled off.

Following the anchorage and before the fastening of the edge, a material-removing working step may be performed in order to ensure a smooth finish toward the narrow side, it being possible for material of the cover layers and/or the edge support(s) to be removed.

Although it is therefore preferred for the edge support to be anchored in such a way that it is lying between the cover layers and is not lying against the cover layers at the end sides, nevertheless, according to preferred embodiments, the sonotrode will drive the edge support against the end sides of the cover layers and between the cover layers, while at the same time coupling in mechanical oscillations, by a pressing force in the horizontal direction—i.e. application of force parallel to the plane of the cover layers. The liquefaction of the thermoplastic material in this case takes place at the end sides against the cover layer or the cover layers and/or by friction on the inner surface of the cover layers.

According to one specific embodiment, the rear support comprises a guiding portion, which already lies between the cover layers when the rear support is put in place and before the mechanical oscillations are coupled in, to be precise in such a way that it is in surface-area contact with the inside of both cover layers and thereby acts in a guiding manner during further pressing in by the sonotrode. The guiding portion protrudes beyond contact surfaces with the cover layers into the region between the cover layers (i.e. possibly into the region of the filling).

In order that the mechanical oscillations can be coupled into the edge support, the latter has a corresponding coupling-in surface. In the case of the embodiments mentioned above, with the pressing force in the horizontal direction, this coupling-in surface lies on the rear side (that is to say proximally) and is substantially vertical, and for example approximately parallel to the extent of the narrow side.

According to an alternative embodiment, the pressing force is not exerted horizontally, but vertically by the sonotrode. If that is the case, the sonotrode has a portion which protrudes into the space between the cover layers dur-

ing the anchoring process. By contrast with the preferred situation when anchorage is effected by a horizontal force—the anchorage in the upper and lower cover layers then does not take place simultaneously but successively. This embodiment is most particularly preferred in conjunction with edge supports running in the manner of a zigzag or network.

In the case of these embodiments with a vertical pressing force, during the anchoring process the coupling-in surface lies in the interior of the region between the cover layers, and, for example, lies approximately horizontally.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention are described in detail below on the basis of drawings. The drawings are schematic and not to scale. In the drawings, the same designations refer to the same or analogous elements and:

FIGS. 1a-d show a method according to the invention with a first embodiment of edge supports;

FIG. 2 shows a variant with an endless edge support;

FIGS. 3a and 3b show a continuous strip provided with edge supports;

FIG. 4 shows an edge support placed at an angle;

FIGS. 5a and 5b show a method according to the invention with a further embodiment of an edge support;

FIGS. 6a and 6b show a method according to the invention with yet another embodiment of an edge support;

FIG. 7 shows a variant of an edge support with a hybrid structure; and

FIGS. 8a and 8b show a method with a further embodiment of edge supports in another configuration.

#### DETAILED DESCRIPTION OF THE INVENTION

The cut-to-size lightweight building board that can be seen in FIGS. 1a-1d comprises—as also in the embodiments described below—an upper cover layer 1.1 and a lower cover layer 1.2. The cover layers are produced from a derived timber material; for example, they are formed as particle boards, fiberboards or laminated (plywood) boards. The invention is also suitable, however, for the application where the cover layers are made of other materials, under some circumstances materials that are not wood-based, which have sufficient mechanical strength and dimensional stability and comprise structures that are suitable for interpenetration with liquefied thermoplastic material, for example plastic- or metal-based materials, in particular also composite materials.

The thickness of the cover layers may be chosen according to the applications. If the cover layers are made of a derived timber material, the thickness may be, in particular, 10 mm or less, for example between 2 mm and 8 mm, since for such thicknesses there is specifically a need for the edge to be supported.

Arranged between the cover layers is a filling 2. This consists of a material that is light in comparison with the cover layers, for example a honeycomb structure made of card or a similar material. Other fillings forming walls with cavities lying in between are also conceivable, for example regularly arranged strips (the lightweight component is then sometimes referred to as a “multi-wall sheet”) or tubular structures. Furthermore, the use of Styropor or similar foams as well as, for example, aluminum honeycombs is also conceivable. Quite generally, the invention is not dependent on the type of filling and works irrespective of the nature of the filling.

FIGS. 1a, 1b and 1d show sectional representations through a lightweight component during various method

steps (corresponding to a section along the line B-B in FIG. 1c), and FIG. 1c shows a plan view (from the direction of the arrow C in FIG. 1b) of a region of the lightweight component during the method according to the invention.

An edge support 3 of the type depicted in FIG. 1a consists of a thermoplastic material, for example a polymer such as polyamide, a polycarbonate or a polyester carbonate, or else an acrylonitrile-butadiene-styrene (ABS), styrene acrylonitrile, polymethyl methacrylate, polyvinyl chloride, polyethylene, polypropylene and polystyrene. In addition to the thermoplastic polymer, the material may also comprise suitable fillers, for example reinforcing fibers, for example glass or carbon fibers. Quite generally, all materials with a sufficiently high strength, and sufficiently high modulus of elasticity of, for example, at least 0.5 GPa, that can be locally liquefied by ultrasound are suitable. These materials are generally the same materials that are also suitable for ultrasonic welding. To take an example, ABS is a particularly suitable material.

The edge support 3 has a vertical extent that is a little less than the thickness of the lightweight building board. At the contact surface 3.1 with the cover layers 1.1, 1.2, it comprises energy directors, which are formed for example as projecting corners or ridges tapering to an edge. Furthermore, formed in the region between the cover layers 1.1, 1.2 is a projecting guiding portion 3.2, the vertical extent of which corresponds to the distance between the cover layers 1.1, 1.2. A rear surface 3.3 (with respect to the lightweight board in the configuration of FIG. 1a) is substantially planar and suitable as a coupling-in surface for the mechanical oscillations. For the anchorage of the edge support 3 to the narrow side of the lightweight building board, the edge support is positioned on the narrow side and pressed against it (arrows 7). The pressing force is exerted by a sonotrode 5, the coupling-out surface 5.1 of which lies flat against the coupling-in surface 3.3. At the same time, an inwardly directed supporting force (arrows 8) is exerted on the cover layers 1.1, 1.2, and mechanical oscillations 9 are coupled into the edge support 3 through the sonotrode 5. The guiding portion 3.2 thereby ensures that the orientation of the edge support is defined and that no undesired tilting occurs during the subsequent melting.

The mechanical vibrations are, for example, ultrasonic oscillations. In general, oscillations in a frequency range between 2 kHz and 100 kHz, preferably between 10 kHz and 40 kHz, for example about 20 kHz, are used; other frequencies are not ruled out. The power of the device generating the oscillations—a commercially available ultrasonic device may be used—depends on the dimensionings; it may lie in the range between 100 W and 2 kW.

The pressing force 7 (and possibly the supporting force 8) may optionally be exerted already before the mechanical oscillations begin, in order to press the edge support 3 a little into the material of the cover layers already in the region of the contact surface 3.1, which in the subsequent step makes it even easier for the edge support to be guided and can ensure optimum introduction of the mechanical oscillations into the edge support. It is particularly favorable if the supporting force 8 is exerted already before the edge support is placed on, in order to ensure that the cover layers are kept fixed in position during the entire process.

As soon as the mechanical oscillations 9 are coupled in, mechanical energy is absorbed, in particular in the region of the contact surfaces—on account of the energy directors and the friction with the material of the cover layers—and as a result the liquefying of the thermoplastic material is initiated. The material begins to melt and is pressed into the cover layers 1.1, 1.2. At the same time, incipient melting of the thermoplastic material may also take place in the region of the

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horizontal supporting surfaces **3.4** of the guiding portion, on account of the friction with the cover layers.

After the mechanical oscillations end, the liquefied material sets again, and a stable positively engaging connection with the material of the cover layers is obtained. This is represented in FIG. **1b**.

This anchoring process is carried out for a plurality of edge supports **3** along the narrow side, the edge supports preferably being arranged at regular intervals, which can be seen particularly well in FIG. **1c**.

In this case, each edge support may be anchored individually, or a number of edge supports may be inserted simultaneously with the aid of an extended sonotrode, covering a number of edge supports.

This has the overall effect of producing an extended region of the narrow side, which is provided with edge supports in such a way that the edge **11** can be adhesively attached to the flat rear side **3.3**, serving in the previous step as a coupling-in surface for the mechanical oscillations. This is illustrated in FIG. **1d**.

Before the adhesive attachment of the edge, a milling or grinding of the narrow side—including the edge support—may possibly also take place, in order that the lightweight component has a smooth, regular surface in the region of the narrow side.

If an edge support **3** of the type represented in FIG. **1a** is of a transparent configuration, electromagnetic radiation may be coupled into it instead of or in addition to mechanical vibrations, for example from the rear-side surface **3.3** into the region of the contact surfaces **3.1**, the latter being configured by roughnesses, pigments or other means in such a way that the electromagnetic radiation is absorbed there. The absorption has the effect that the thermoplastic material in the region of the interface heats up, and ultimately liquefies, which with the simultaneous exertion of a pressing force **7** can likewise lead to the anchorage as represented in FIG. **1b**.

FIGS. **1a** to **1d** illustrate the fastening of a plurality of discrete edge supports arranged at regular intervals. Instead, however, a continuous edge support (“endless edge support”) may also be used. Such an edge support may, for example, comprise a cross section such as the cross section illustrated in FIG. **1a** of the discrete edge supports described above. It may be obtained in a continuous process with a sonotrode that is advanced in the manner of a roller or with a sonotrode that is moved over the rear side in the manner of a smoothing iron. However, a continuous edge support may also be fastened portion by portion by an iterative process, which is illustrated in FIG. **2**. FIG. **2** shows a view analogous to FIG. **1c** with a continuous edge support **3**. The regions **12.1**, **12.2**, **12.3**, **12.4**, which are covered by the sonotrode during the anchoring, are represented by dashed lines. As depicted, they are chosen, for example, to be slightly overlapping.

As represented in FIG. **2**, the continuous edge support may also comprise, on the rear side, a corresponding decoration and form the edge, in particular if the edge is in any case constructed as a laminate.

If, as in FIGS. **1a-1d**, discrete edge supports are anchored, it may be of advantage if the edge supports **3** do not have to be placed individually but are supplied in a form in which they are fastened at the ideal intervals on a connecting element, for example a strip. This is illustrated in FIGS. **3a** and **3b**. FIG. **3a** shows a front view—i.e. a view from the lightweight component side (arrow A in FIG. **3b**)—of such an arrangement. FIG. **3b** shows the representation of a section along the line B-B in FIG. **3a**. The edge supports **3** in FIGS. **1a-1d** of the type depicted are adhesively attached on the strip **14** or welded onto the strip. After the anchorage of the edge supports **3**, the

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strip **14** may be pulled off in a process of the type described on the basis of FIG. **1a** to **1d**, or it may also remain where it is, so that its rear side serves as an adhering location for the attachment of the edge **11**. As a further alternative, the strip may be supplied in a relatively stable form and already be provided with the desired decoration on the rear side, so that it serves itself as the edge. If the connecting element does not serve as the edge, it does not have to be configured as a strip, but may, for example, also be a network, an assembly of a number of relatively narrow strips arranged next to one another or some other flexible connecting means defining the distances between the edge supports.

The variant of the edge support depicted in FIG. **4** differs from those of FIGS. **1a-1d** and **3a-3b** in that, on account of its outer form and the form of the guiding portion, it is at an angle when it is placed in contact with the lightweight component. This has advantages in particular whenever, following the anchorage, the narrow side is also milled or ground. In the case of a straight arrangement—i.e. if the edge support is perpendicular on the flat sides—there is the risk of the edge support as a whole being caught by a milling or grinding head and, in the worst case, torn out. The angled position allows the head to act continuously on the edge support.

The angled position of the edge support also makes it possible for the edge to be supported over a greater length.

The variant according to FIG. **4** may optionally—as indicated by the dashed lines—likewise be pre-assembled on a strip.

FIGS. **5a** and **5b** show an embodiment in which, in the anchored state, the contact surfaces **3.1** with the energy directors do not lie against the narrow side at the end but lie against the inside of the cover layers **1.1**, **1.2** adjacent to the narrow side. An outer height  $h_1$ , i.e. the height measured between the edges or tips of the energy directors, is in this case dimensioned such that it is greater than the distance between the cover layers **1.1**, **1.2**. In other words, when the edge support **3** is inserted between the cover layers, the energy directors are against said cover layers, so that, as in the case of the examples described above, a horizontal pressing force **7** can be applied along the plane of the lightweight component. An inner height  $h_2$ , i.e. a height without the energy directors, may correspond approximately to the distance between the cover layers.

In the embodiment according to FIGS. **5a** and **5b**, the anchorage takes place primarily on the inside of the cover layers. The embodiment has the advantage that the edge support can disappear completely between the cover layers, i.e. pressing force **7** and mechanical oscillations **9** can be applied until the sonotrode is against the cover layers at the ends. In the case where the sonotrode is formed in such a way, the edge support can even be recessed just a little.

Even if in the case of the edge support of this embodiment there is no guiding portion projecting beyond the contact surface **3.1**, the actual edge support body (i.e. the edge support without the energy directors) can act in a guiding manner during introduction if the inner height  $h_2$  is chosen to correspond to the distance between the cover layers. This also applies if the edge support according to FIG. **5a** and FIG. **5b** is formed at an angle by analogy with FIG. **4**.

Also in the case of edge supports of this embodiment, a supporting force **8** is exerted on both cover layers. The supporting force **8** is especially important here, since the introduction of the edge support according to FIGS. **5a** and **5b** would have the tendency to push the two cover layers apart if no supporting force were present.

The embodiment according to FIGS. **5a** and **5b**—like that according to FIGS. **1a-1d**—may also be brought about by the

anchorage of individual edge supports, the anchorage of a number of edge supports connected to one another by a strip (or network or the like; a strip may optionally form the edge) or by the anchorage of a continuous edge support (with or without an edge).

It is a preferred principle of the invention that the sonotrode acts on the edge support from the narrow side—that is to say not through the cover layers. In the embodiments described above, the pressing force 7 acts from the end side, that is to say horizontally. An embodiment in which the sonotrode likewise acts on the edge support from the narrow side, but in which the pressing force is applied vertically, is described below on the basis of FIGS. 6a and 6b.

FIG. 6a shows a view analogous to FIG. 1c from the front side; FIG. 6b shows a sectional representation with a sonotrode. As can best be seen in FIG. 6a, the edge support 3 runs continuously, that is to say as in FIG. 2 as an “endless edge support”. The edge support 3 comprises horizontal regions 3.5, which respectively lie with the contact surface 3.1 against one of the cover layers 1.1 and 1.2, as well as transitional regions 3.6 connecting these horizontal regions. The horizontal regions 3.5 are respectively located alternately on the inside of the upper cover layer 1.1 and of the lower cover layer 1.2.

FIG. 6b illustrates how the edge support 3 according to FIG. 6a is anchored in the lightweight component. The sonotrode has the form of a T or L piece with a laterally protruding portion 5.2, which is inserted into the intermediate space between the cover layers 1.1, 1.2. The upper side 5.1a and the underside 5.1b of this portion form the coupling-out surfaces for the anchorage of an upper horizontal region 3.5 in the upper cover layer 1.1 and a lower horizontal region 3.5 in the lower cover layer. FIG. 6b illustrates the situation during the anchorage of a lower horizontal region 3.5. The pressing force 7 is downwardly directed. In this embodiment, the supporting force 8 is at the same time the counter force opposing the pressing force. In the case of the anchorage on the underside, it can be applied simply by the lightweight component resting on a horizontal underlying surface. In the case of the anchorage of the upper horizontal regions—with an upwardly directed pressing force—the counter force—then acting on the upper cover layer 1.1—is advantageously actively applied.

During the anchorage of the edge support 3, for example, upper and lower regions are anchored alternately along the narrow side. However, it is also possible, for example, first to anchor all the upper regions and then to anchor all the lower regions. Optionally, this may be accompanied by turning the lightweight component as a whole around. In the latter case, active application of the counter force may be made superfluous, in that during the anchoring there is always downward pressing and the supporting force can always be applied by the underlying surface against which the pressing force is directed.

The attachment of the edge with the decoration takes place by analogy with the above embodiments; here, too, a milling or grinding of the narrow side may take place in advance. This embodiment is even particularly suitable for this, since, as illustrated, the edge support can be anchored such that it is set back with respect to the end side of the cover layers. If it is done in this way, it is necessary for the cover layers to be removed until they are flush with the edge support, in order for adhesive attachment of the edge to become possible.

As a difference from the embodiments described above, however, in the case of the example according to FIGS. 6a and 6b, of course, the coupling-in surface does not serve as the rear-side surface for fastening the edge, but the outer surface.

Many other embodiments besides are conceivable, for example with network- or grid-like edge supports, differently formed sonotrodes, etc. It is also possible to construct the edge support from a number of materials and not just from one material, as in the examples illustrated above. FIG. 7 shows an edge support 3, which comprises, at least in the region of the contact surface 3.1, a thermoplastic part 3.11 and a non-thermoplastic part 3.12, for example of a building material containing wood. If such a part 3.12 is attached on the rear side, that may be particularly advantageous, for example, for the adhesive bonding with the edge.

Depicted in FIGS. 8a and 8b is an arrangement in which the sonotrode 5 acts on the inside of the edge support 3 and exerts the pressing force 7 from the inside. FIG. 8a shows a sectional representation analogous to FIGS. 1a, 1b, 1d, 5a and 6b; FIG. 8b shows a section along the line B-B in FIG. 8a. The mechanical vibrations 9 are coupled into the sonotrode 5, which engages behind the edge support in an L-shaped manner. A counter element 15 is used to apply the necessary counter force 7'. The liquefaction takes place here in the region of the interface between the sonotrode 5 and the edge support 3, it being possible for the edge support to comprise energy directors 3.8, whereby the liquefaction reliably takes place directly at the interface on account of the vibrations coupled into the edge support. As indicated in FIG. 8a, on account of the pressing force, the liquefied thermoplastic material is displaced upward and downward and forced into structures of the cover layers, which brings about the anchorage. Even if the penetration of the cover layers with thermoplastic material will generally not be as intensive as when the edge support itself is pressed against the cover layer and liquefied in contact with it, even with this procedure sufficient anchorage can nevertheless be obtained.

In an arrangement that is virtually identical to FIGS. 8a and 8b, the mechanical vibrations can also be coupled into the edge support 3 from the outside, the liquefaction taking place in contact with the counter element. In such an arrangement, the roles of the sonotrode and of the counter element are changed over in FIGS. 8a and 8b, i.e. 15 then refers to the sonotrode and 5 refers to the counter element. The vibrations 9 are then coupled into the sonotrode 15; 7' refers to the pressing force and 7 refers to the counter force.

The method according to FIG. 8a and 8b or the variant thereof can also be carried out by energy other than mechanical energy, for example heat, being coupled into the edge support. Instead of a sonotrode, a heating element is then used as the tool.

What is claimed is:

1. A continuous edge structure being an edge or edge support for a lightweight building element, wherein:
  - the lightweight building element is a planar structure two cover regions and a filling region between the cover regions;
  - the edge structure comprises contact surfaces with a thermoplastic material shaped to lie against the cover regions in an outer surface of the lightweight building element and further comprises, opposite the contact surfaces, a coupling-in surface for coupling energy into the edge structure;
  - the edge structure is shaped so that at least a portion of the thermoplastic material is liquefied and pressed into the cover regions when energy is coupled into the edge structure while the contact surfaces are pressed against the cover regions;

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the edge structure comprises at least regions which are formed to run between the cover regions after the pressing the thermoplastic material portions into the cover regions; and,

the edge structure is continuously extended to run along an edge of the lightweight building element.

2. The edge structure according to claim 1 being a laminate of an edge with a decoration and an edge support or edge support elements comprising the thermoplastic material.

3. The edge structure according to claim 1 being free of elements protruding vertically beyond the cover regions.

4. The edge structure according to claim 1 further comprising energy directors at the contact surfaces.

5. The edge structure according to claim 1, wherein the contact surfaces with the thermoplastic material extend continuously along the edge.

6. The edge structure according to claim 1, comprising a strip extended continuously along the edge and comprising the coupling-in surface, the edge structure further comprising a plurality of edge support elements attached to the strip.

7. The edge structure according to claim 6, wherein the strip has a decoration on a rear side.

8. The edge structure according to claim 7, wherein the rear side comprises the coupling-in surface.

9. A method of fastening an edge to a lightweight building element, the method comprising the steps of:

providing the lightweight building element, being a planar structure with two cover regions and a filling region between the cover regions;

providing a continuously extended edge structure, the edge structure comprising contact surfaces with a thermoplastic material shaped to lie against the cover regions in an outer surface of the lightweight building element, and, opposite the contact surfaces, a coupling-in surface for coupling energy into the edge structure;

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coupling energy into the edge structure and pressing the contact surfaces against the cover regions until at least a portion of the thermoplastic material is liquefied and pressed into the cover regions; and

repeating or continuing the steps of coupling and pressing until the edge structure is attached to the lightweight building element at a plurality of discrete locations or over an extended region along an edge of the lightweight building element.

10. The method according to claim 9, wherein the step of coupling energy into the edge structure comprises coupling mechanical vibration into the edge structure.

11. The method according to claim 9 wherein continuing the steps of coupling and pressing comprises moving along the edge a roller capable of coupling energy into the edge structure through the coupling-in surface.

12. The method according to claim 9, wherein continuing the steps of coupling and pressing comprises moving along the edge a flat tool capable of coupling energy into the edge structure through the coupling-in surface.

13. The method according to claim 9, wherein repeating the steps of coupling and pressing comprises repeatedly pressing a tool capable of coupling energy into the edge structure through the coupling-in surface against regions of the edge.

14. The method according to claim 13, wherein the regions of the edge are overlapping.

15. The method according to claim 9, wherein the edge structure is an edge support, and wherein the method comprises the further step of attaching an edge to the edge support.

16. The method according to claim 15, wherein the step of attaching is carried out after the step of repeating or continuing.

17. The method according to claim 9, wherein the edge structure comprises the edge.

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